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(54) Gas generant compositions using dicyanamide salts as fuel.

(57) A gas generant composition includes a fuel, at least 25 wt% of which is an alkali, alkaline earth, and/or transition metal salt of dicyanamide and an oxidizer which is an ammonium, alkali metal and/or alkaline earth metal salt of a chlorate, perchlorate or nitrate.

Preferred oxidizers are nitrates.

Optionally, a portion of the oxidizer may be a transition metal oxide, such as iron oxide or cupric oxide. In addition to their oxidizing function, these oxides provide hard particles, facilitating compaction of the composition into pellets or other consolidated solid shapes. For pelletization purposes, it is preferred that between about 10 and about 50 wt% of the total oxidizer content be a transition metal oxide, particularly cupric oxide.

As is taught in U.S. Patent No. 5,139,588, the teachings of which are incorporated herein by reference, the cations of the fuel salts and oxidizers are preferably mixtures of alkali metal cations, i.e., lithium, sodium and potassium, and alkaline earth metal cations, i.e., magnesium, calcium, strontium, barium and cerium. Upon combustion, the alkali cations form liquid slag components and the alkaline earth metal cations form solid slag components, the mixture of liquid and solid salts forming clinkers which can be readily removed from the gas stream by filtration. The ratio of solid to liquid combustion slag components may be adjusted by the ratio of alkaline earth metal cations to alkali metal cations.

Alumina, silica or mixtures thereof may be added to scavenge corrosive alkali metal oxides, such as sodium oxide and potassium oxide. Accordingly, the composition of the present invention may contain alumina and/or silica at a level of between about 0.5 and about 30 wt%. The alumina and/or silica may be in the form of particulates or as fibers, such as fibers of various silica/alumina content. Alumina is generally preferred over silica, being a more efficient scavenger.

A binder is optionally added at a level of up to 10%, preferably at least about 0.5wt%. Suitable binder materials include but are not limited to molybdenum disulfide, graphite, polytetrafluoroethylene, Viton ® (a copolymer of vinylidene fluoride and hexafluoropropylene), nitrocellulose, polysaccharides, polyvinylpyrrolidones, polycarbonates, sodium silicate, calcium stearate, magnesium stearate and mixtures thereof. Preferred binder materials are molybdenum disulfide and polycarbonates.

Alkali metal and alkaline earth metal carbonates and/or oxalates may optionally be added up to about 10 wt%. These act as coolants, lowering the combustion temperature. Lower combustion temperatures minimize production of toxic gases, such as CO and NO_x. Generally, if used, these coolants are used at a level of at least about 1 wt%.

As noted above, the alumina and/or silica may be in the form of fibers. Fibers help to mechanically reinforce the consolidated unburned material and subsequently consolidate slag material formed by burning the composition. Graphite fibers, e.g., up to about 10 wt%, typically at least about 1 wt%, may be also be used either alone as the sole fibrous material or in conjunction with other fibrous materials.

The invention will now be described in greater detail by way of specific examples.

Examples 1-4

Gas generant compositions in accordance with the invention are formulated as follows, all amounts being in weight %:

Example	1	2	3	4		
					Function	
Component						
Sodium Dicyanamide	31.9	28.66	23	19	Fuel	
Guanidine Nitrate			10	15	Co-Fuel	
Strontium Nitrate	68.1	61.34	57	51	Oxidizer	
Lithium Carbonate		5	10	15	Coolant	
Aluminum Oxide		5			Slag Former	
Thermochemical Calculations						
Tc* (°K)	2444	2039	1977	1831		
N ₂ (mole/100g)	0.51	.77	.82	.81		
CO ₂ (mole/100g)	0.49	.53	.47	.44		
H ₂ O (mole/100g)	0	0	.25	.34		

Example 5

A generant composition in accordance with the invention are formulated as follows, all amounts being in weight %:

Example	5	
		Function
Component		
Sodium Dicyanamide	20.69	Fuel
Guanidine Nitrate	11.76	Co-Fuel
Strontium Nitrate	48.00	Oxidizer
Lithium Carbonate	6.87	Coolant
Cupric Oxide	12.75	Co-oxidizer/binder
	100.00%	
Thermochemical Calculations		
Tc* (°K)	1947	
N ₂ (mole/100g)	0.77	
CO ₂ (mole/100g)	0.45	
H ₂ O (mole/100g)	0.29	

* Chamber Temperature

Examples 6 & 7

Examples of practical formulations of zinc and copper dicyanamide are shown in Table Ex. 6 and Ex.7 respectively. The compositions were prepared by mixing the materials in an aqueous slurry (approximately 30 25%), drying the composition, and screening the dried mixture. Burn rate slugs were pressed and burning rate measured at 1000 psi.

Table Ex. 6

Cupric Dicyanamide Formulations (Weight %)					
Mix	1	2	3	4	
Component					
Cupric Dicyanamide	26.77	20.57	25.22	19.03	
Guanidine nitrate	10	20	10	20	
Lithium carbonate	10	10	10	10	
Strontium nitrate	53.23	49.43	44.78	40.97	
Cupric oxide	0	0	10	10	
Thermochemical Calculations					
Rb (ips @ 1000 psi)	.75	.71	.67	.63	
Moles/100 gm	1.70	1.95	1.60	1.86	

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Table Ex. 7

Zinc Dicyanamide Formulations (Weight %)		
Mix	1	2
Component		
Zinc dicyanamide	34.14	24.46
Strontium Nitrate	65.86	60.54
Lithium carbonate	0	5
Ammonium diliturate	0	10
Thermochemical Calculations		
Rb (ips @ 1000 psi)	0.65	0.7
Miles/100 gm.	1.51	1.60

Claims

1. A gas generant composition comprising between 10 and 60 wt% of a fuel, at least 25 wt% up to 100% of which is selected from alkali, alkaline earth, and transition metal salts of dicyanamide and mixtures thereof, balance other fuel and between 40 and 90 wt% of an oxidizer selected from ammonium, alkali metal and alkaline earth metal chlorates, perchlorates, nitrates and mixtures thereof.
2. A gas generant composition according to claim 1, further containing between 0.5 and 10 wt% of a binder.
3. A gas generant composition according to claim 2 wherein said binder is selected from molybdenum disulfide, graphite, polytetrafluoroethylene, vinyl fluoride/hexafluoropropylene copolymer, nitrocellulose, polysaccharides, polyvinylpyrrolidones, polycarbonates, sodium silicate, calcium stearate, magnesium stearate and mixtures thereof.
4. A gas generant composition according to claim 2 wherein said binder comprises molybdenum disulfide or a polycarbonate.
5. A gas generant composition according to any preceding claim further containing between 1 and 10 wt% of a coolant selected from alkali metal and alkaline earth metal carbonates, oxalates and mixtures thereof.
6. A gas generant composition according to any preceding claim further containing between 1 and 10 wt% of graphite fibers.
7. A gas generant composition according to any preceding claim further containing between 0.5 and 30 wt% alumina and/or silica.
8. A gas generant composition according to any preceding claim containing, in addition to said salt(s) of dicyanamide, up to about 50 wt% of a fuel selected from salts of bitetrazole, aminotetrazole, nitrotriazolone, triazolone, salts of nitrobarbituric acid, salts of nitroorotic acid, nitouracil, salts of guanidine, salts of amino-substituted guanidine, and mixtures thereof.
9. A gas generant composition according to any preceding claim wherein said salt of dicyanamide is sodium dicyanamide.
10. A gas generant composition according to any one of claims 1 to 8 wherein said salt of dicyanamide is calcium dicyanamide.

11. A gas generant composition according to any one of claims 1 to 8 wherein said salt of dicyanamide is cupric dicyanamide.
- 5 12. A gas generant composition according to any one of claims 1 to 8 wherein said salt of dicyanamide is zinc dicyanamide.
13. A gas generant composition according to any preceding claim wherein between 10 and 50 wt% of said oxidizer comprises a transition metal oxide or a mixture of transition metal oxides.
- 10 14. A gas generant composition according to Claim 13 wherein said transition metal oxide is ferric oxide, cupric oxide or a mixture thereof.
- 15 15. A gas generant composition according to claim 14 wherein said transition metal oxide is cupric oxide and said dicyanamide salt is cupric dicyanamide.

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13.09.95 Bulletin 95/37(71) Applicant: MORTON INTERNATIONAL, INC.
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EUROPEAN SEARCH REPORT

Application Number
EP 94 30 8331

DOCUMENTS CONSIDERED TO BE RELEVANT			CLASSIFICATION OF THE APPLICATION (Int.Cl.6)						
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim							
D, A	US-A-4 386 979 (C.H. JACKSON, JR.) * column 2, line 30 - column 3, line 57 * ---	1	C06D5/06 C06B43/00						
A	EP-A-0 519 485 (DYNAMIT NOBEL AKTIENGESELLSCHAFT) * claims * -----	1							
			TECHNICAL FIELDS SEARCHED (Int.Cl.6)						
			C06D C06B						
<p>The present search report has been drawn up for all claims</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="width: 33%;">Place of search</td> <td style="width: 33%;">Date of completion of the search</td> <td style="width: 34%;">Examiner</td> </tr> <tr> <td>THE HAGUE</td> <td>30 June 1995</td> <td>Schut, R</td> </tr> </table>				Place of search	Date of completion of the search	Examiner	THE HAGUE	30 June 1995	Schut, R
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<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document</p>									